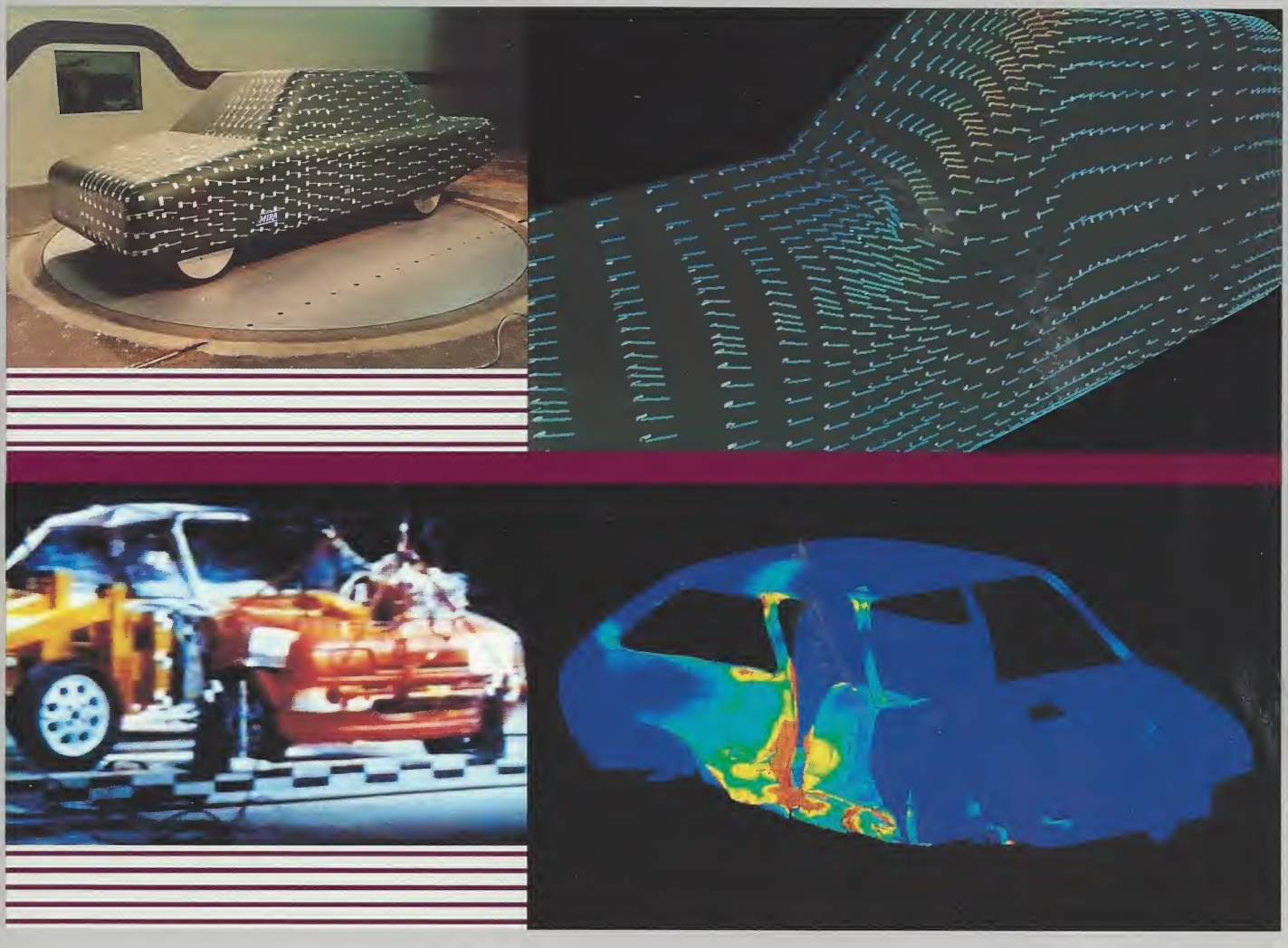
Automotive
APPLICATIONS



CRAY

Delivering the power...

Cray Research
Automotive Customers

France
Peugeot S.A. (Automobiles Citroën)
La Manufacture Française des Pneumatiques MICHELIN

Italy
Fiat Auto

Japan
Honda Research and Development Company, Ltd.
Mitsubishi Motors Corporation
Nissan Motor Company
Toyota Motor Corporation

Sweden
Saab-Scania A.B.

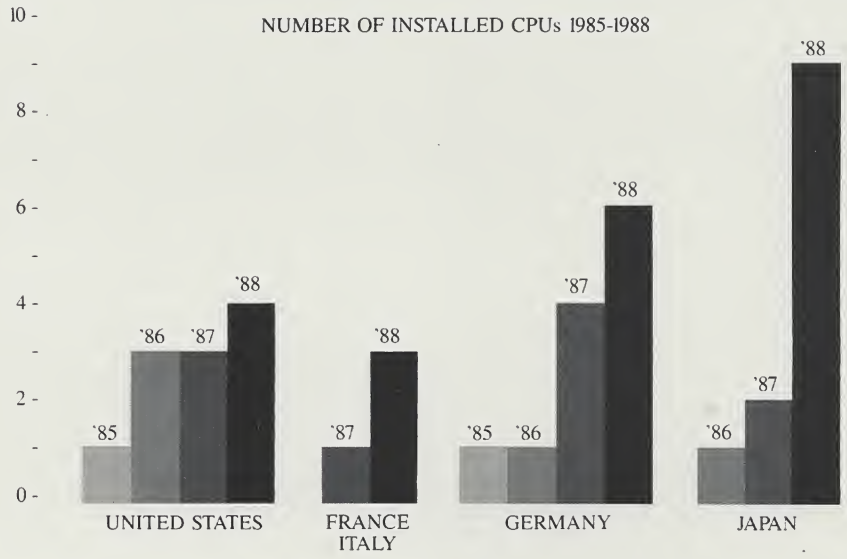
United States
Chrysler Motors
Ford Motor Company
General Motors Research Lab

West Germany
Bayerische Motoren Werke (BMW)
Daimler-Benz
EDS/Adam Opel
Volkswagen

Cray Research is delivering the power to meet automotive challenges on three continents. Having established itself as the leader in automotive supercomputing, Cray Research continues to manufacture computer systems that offer unsurpassed capabilities, easy system integration, extensive network connectivity, and innovative applications.

By using Cray computer systems to integrate numerical simulation techniques into the initial design, development, and testing processes, leaders in the automotive industry can increase overall computing capacity and productivity, decrease overall costs, cut lead time to production, and produce quality vehicles using fewer prototypes.

Cray Computer Systems
Automotive Industry Geographic Distribution



Challenges

The critical role of supercomputing in the automotive industry is evidenced by the dual challenge of balancing consumer demand for sophisticated automotive design and fuel-efficient performance, with manufacturers' stringent design cycles and production schedules, and government regulations for safety and emission control.

Computational analysis offers a cost-effective, low-risk opportunity to quickly generate solutions to these and other complex automotive problems, such as:

- exterior flow analysis on vehicles
- interior flow analysis on passenger compartments and engines
- internal combustion
- manifold and filter flows
- metal solidification in castings
- injection molding
- engine water-jacket cooling
- crash analysis
- structural dynamics analysis on vehicles and engines
- structural acoustics analysis
- driving dynamics and analysis

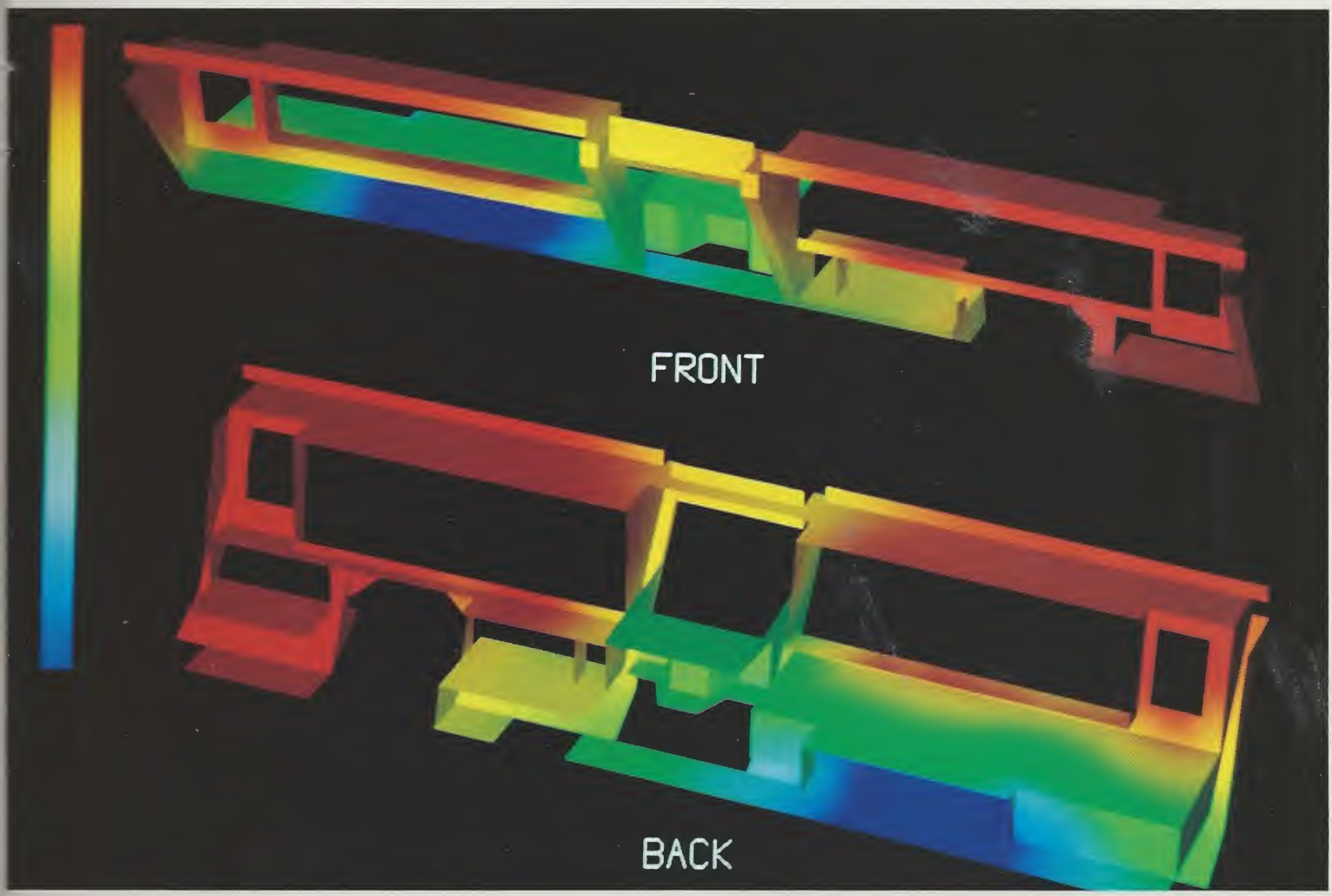
These types of automotive computational analyses provide maximum effectiveness when integrated into the initial planning and development process.

Nissan Motor Company has introduced the (Cray) supercomputer to do precision and large-scale simulations in (computer-aided engineering) CAE environments. Using the Cray supercomputer, the time required to perform car air flow analysis was reduced from 10 hours on a large-scale mainframe to 20 minutes on the Cray supercomputer. We can now do structural analysis and performance simulations that were previously intractable, given the stringent time requirements of the design and development cycles.

Nissan Motor Company, August, 1987.

Simulation of an automotive differential model using MSC/NASTRAN.

Courtesy of General Motors' Chevrolet-Pontiac-Canada (CPC) Analysis Division.



Automobile dashboard injection molding modeled with the C-FLOW package. High pressure areas are shown in red; low pressure areas in cyan; and unfilled areas in dark blue.

Courtesy of V.W. Wang,
Advanced CAE Technology.

Solutions

Complex automotive problems require extensive three-dimensional modeling to generate solutions. To meet specific computing requirements, Cray computer systems are available in a number of models, including the CRAY Y-MP and CRAY X-MP EA computer systems, part of the Extended Architecture (EA) series, and the CRAY-2 and CRAY X-MP computer systems.

Over the years, Cray Research has maintained a close relationship with many third-party software vendors, to offer the most extensive and cost-effective automotive supercomputing solutions.

Applications Software for Cray Computer Systems

Structural and Heat Transfer Analysis

ABAQUS
ADINA
ANSYS
ASKA
BEASY
DYNA3D
DYCAST
MARC
MSC/NASTRAN
PAM-CRASH
PERMAS
PROBE
RADIOSS
UAI/NASTRAN

Computational Fluid Dynamics and Combustion

C-FLOW
CONCHAS
FIDAP
FIRE
FLOTRAN
FLOW3D
FLUENT
FLUENT/BFC
KIVA II
MOLDFLOW
PHOENICS
STAR-CD
VSAERO

Finite Element and Solid Geometric Modeling

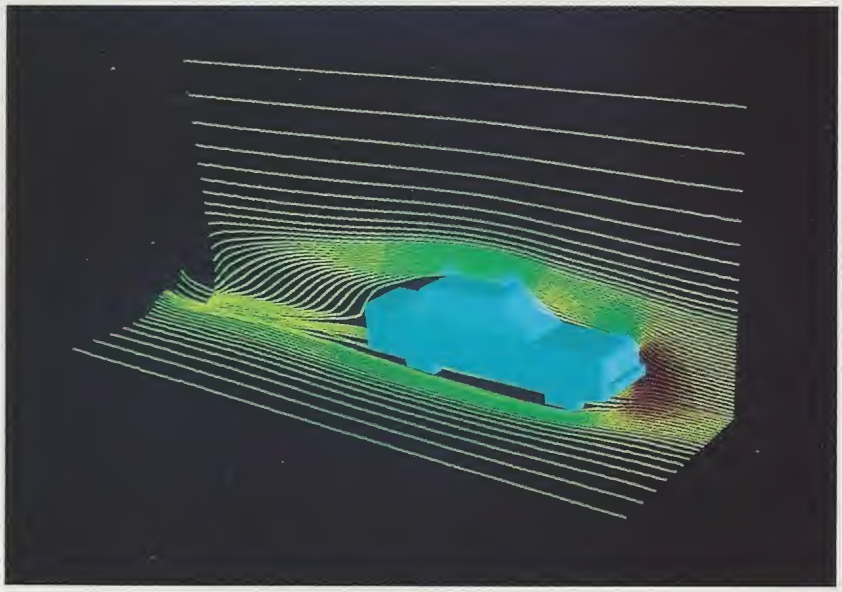
PATRAN II
MOVIE.BYU

Optimization

ADS/NASOPT
CSAR/OPTIM
CSAR/SIZING
NISAOPT
SUPER.DOT

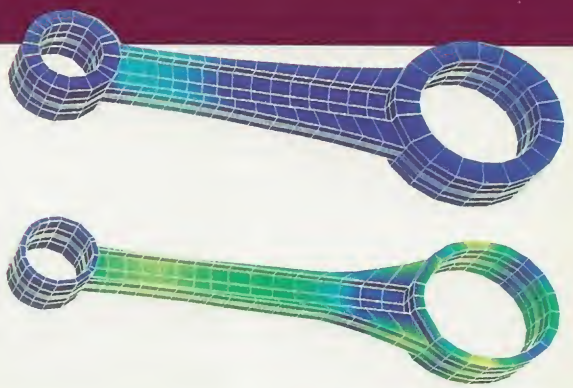
Kinematics

ADAMS
DADS



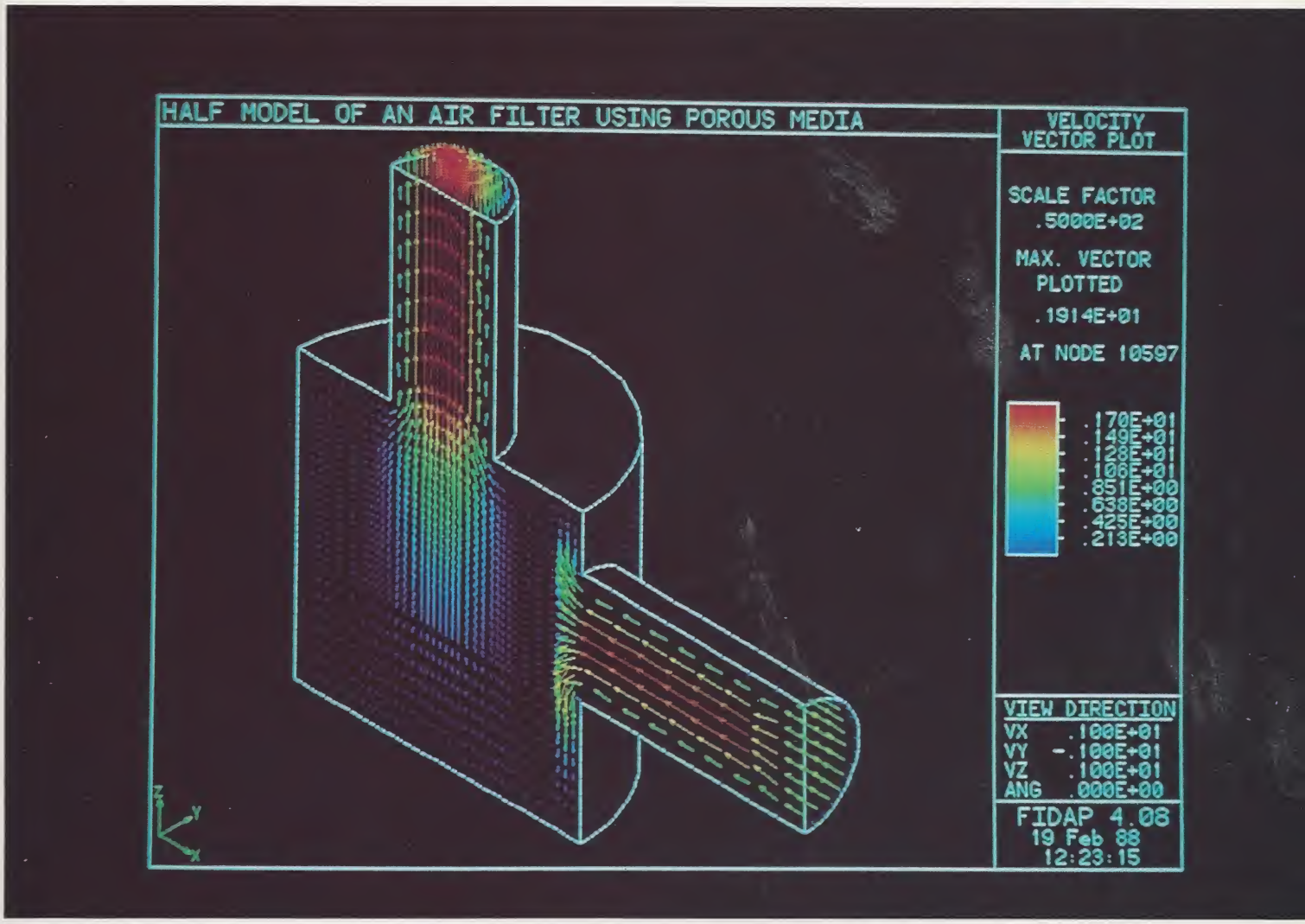
Particle paths surrounding an automobile simulated by FLUENT/BFC. High pressure areas are shown in red; low pressure areas in blue.

Courtesy of Barbara Hutchings, CREARE Inc., and Bill Pien, Ford Motor Co.



Shape optimization analysis for General Motors connecting rod using SUPER.DOT.

Courtesy of General Motors.



Simulation of the flow through a truck air filter porous media using FIDAP. The highest velocity vectors are shown in red; the lowest in blue.

Courtesy of Michael Engelman,
Fluid Dynamics International.

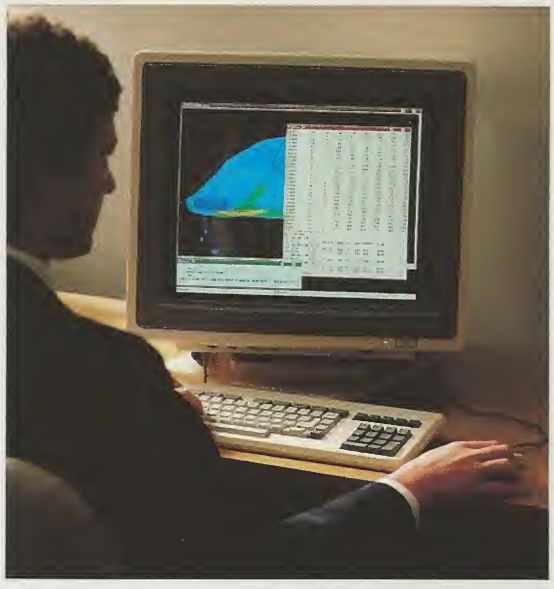
Connectivity

Cray Research supports the Cray operating systems COS and UNICOS.

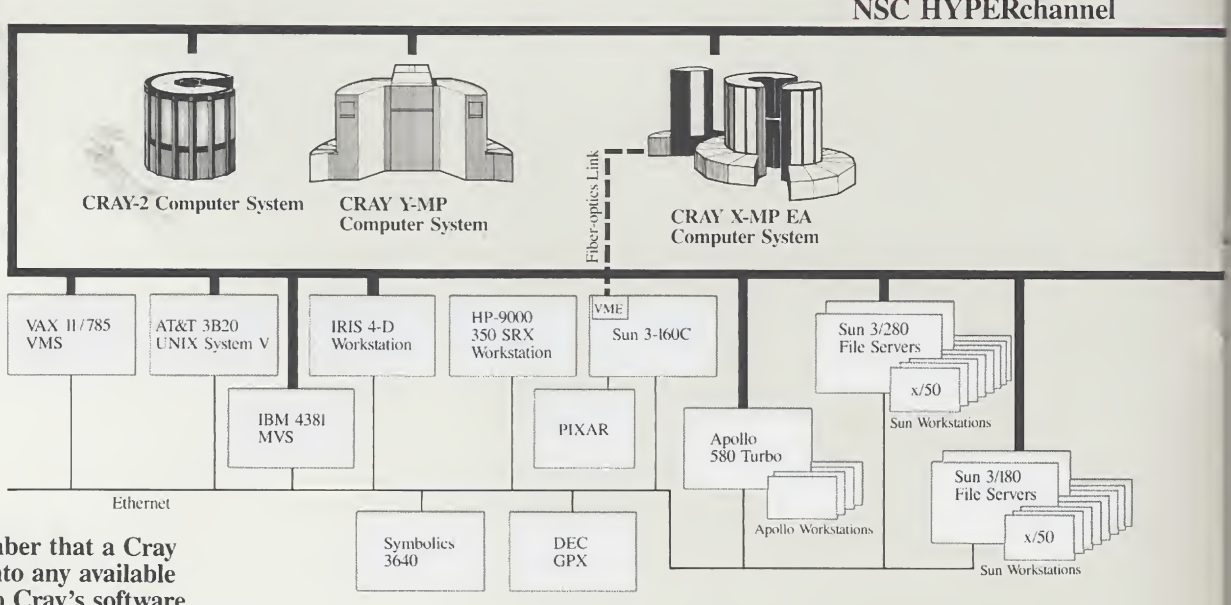
COS, the first Cray operating system, provides connectivity through Cray Research station products, high-performance tape processing, and front-end interactive access.

Based on the AT&T UNIX System V operating system, UNICOS provides smooth system integration and maximum supercomputing performance. UNICOS allows Cray computer systems to be connected to existing systems through the U.S. Department of Defense standard TCP/IP protocol or through Cray Research station products.

To ensure the selection of a computer system that easily fits into a customer's existing hardware and software configurations, Cray Research provides initial site-planning and installation, and ongoing hardware and software support.



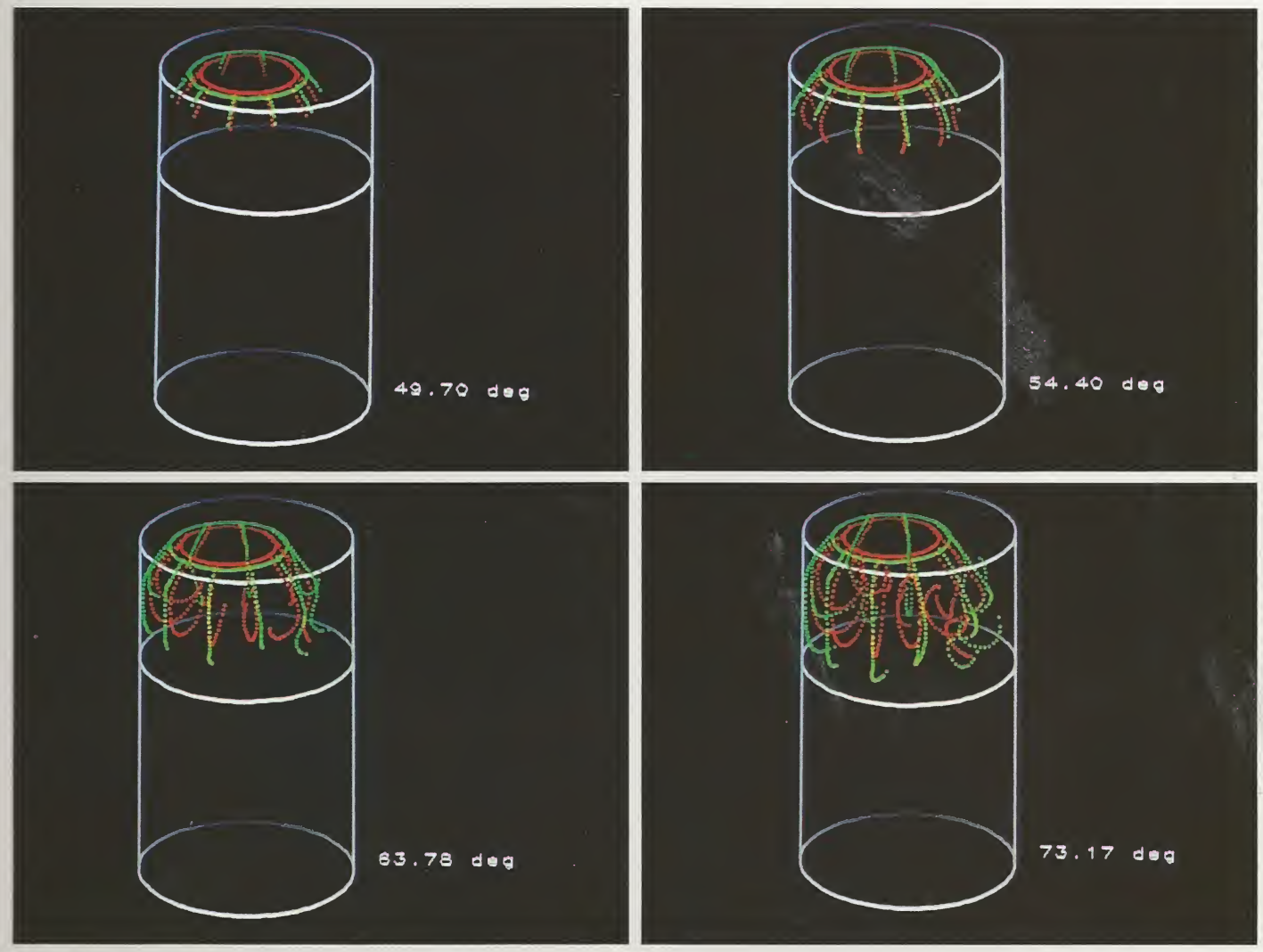
Cray Research network supercomputing allows PATRAN II to be executed under UNICOS on a CRAY X-MP computer system and displayed on an Apollo workstation.



Cray Computer Systems in a TCP/IP Network Environment

"It is important to remember that a Cray system is designed to fit into any available network. This is critical to Cray's software strategy, and our corporate commitment is to interface to industry standards."

Robert H. Ewald, Vice President of the Software Division, Cray Research, Inc.



Evolution of paths of particles originating from the valve of an internal combustion engine during the intake stroke. The number in each frame indicates the crank angle in degrees.

Courtesy of Bernd Binninger,
RWTH Aachen, West Germany.

Futures

Having made significant contributions to automotive supercomputing in areas ranging from automobiles and trucks to tires and electronics, Cray Research is established as an integral part of the automotive industry. With the increasing emphasis on computer-aided design, engineering, and manufacturing, the role of supercomputing is becoming even more critical.

To support ongoing technological development, the Cray Research Industry, Science, and Technology department promotes and sponsors technical symposiums, conferences, and workshops. With their well-balanced architectural design, combining parallel, vector, and high-speed scalar processing, Cray computer systems are delivering the power.

Current automotive trends

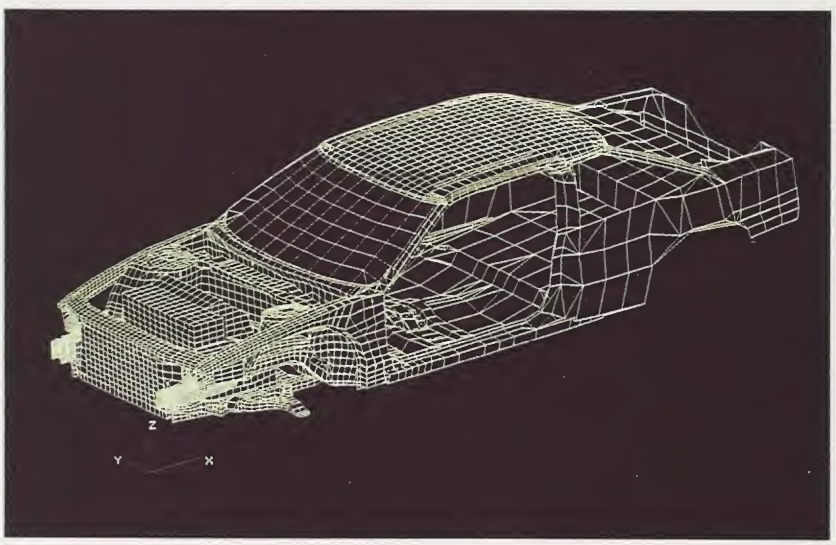
- More extensive use of finite element analysis
- Increased use of computational fluid dynamics
- Proliferation of computer-aided design and engineering (CAD/CAE) workstations
- Extensive use of interactive graphics
- Implementation of distributed computer-aided design and manufacturing (CAD/CAM) systems

Automotive challenges for supercomputing applications software

- Crash simulation/nonlinear high-velocity dynamics
- Design optimization
- Research and development in flexible manufacturing systems
- Complete combustion simulation on engines
- Flow simulation in turbochargers
- Complete metal casting simulations on engines and other parts
- Complete aerodynamic load analyses on cars and trucks
- Complete process simulation of injection molding of large parts, such as body panels and tires
- Analysis of composite materials
- Electronic circuit design and logic analysis

"As Cray Research continues to introduce advanced supercomputers, our software will continue to take advantage of new hardware features. Cray is committed to ensuring that its supercomputers fit into a wide variety of user environments. UNICOS provides functionality and flexibility to users of Cray supercomputers for today and the future."

John A. Rollwagen, Chairman and
Chief Executive Officer, Cray Research, Inc.



Simulation of a car body model using DYNA3D. The model contains 14,931 shell elements and is used for front-impact analysis.

Courtesy of General Motors' Chevrolet-Pontiac-Canada (CPC) Analysis Division.

Photo Credits

Front cover (clockwise from top left): **Tuft flow visualization on a wind tunnel model.** Courtesy of the Motors Industry Research Association (MIRA). **Flow velocity distribution determined by aerodynamic simulation using Harwell-FLOW3D.** Courtesy of MIRA and Harwell Laboratory. **Experimental car for side-impact crashworthiness simulation.** Courtesy of Ford Motor Co. **Side-impact crashworthiness simulation using RADIOSS.** Courtesy of Ford Motor Co.

Trademark and Product Information

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Cray Research, Inc: 1-612-681-3647 or 1-612-681-3475

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